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1990 UPDATE ON JAPANESE RESEARCH AND DEVELOPMENT

Summary

From an overall viewpoint the course of Japanese research and development activities remains rock steady: total spending continues to rise healthily and spending patterns show little change. Closer examination, however, shows that Japanese R&D is responding, albeit gradually, to the country's new responsibilities as the world's second-largest economy. "Internationalization" of Japanese R&D will not be an easy process either for Japanese managers, who must alter their way of doing things, or for foreigners, concerned with Japan's competitive challenge and suspicious of ulterior Japanese motives. Nevertheless, the process has begun and could have a profound global impact in the long run.

Overview

Throughout the 1980s Japanese corporate executives and government leaders gradually realized that the nation's research and development capabilities were on par with those of the United States and European countries. After decades of tutelage in foreign science Japan's steady efforts to build a solid technology base elevated it to a peer position with its former teachers. For the Japanese, who arrange all things in strict hierarchies (very few things are truly "equal" in their minds), this shift in status may take years before being fully accepted. Because of the nation's new economic might, however, foreigners want Japan to go beyond simple equality in the research field and are urging it to assume the role of teacher in some areas. Many Japanese agree that sharing technology is one way their country can play a positive leading role in the international community. Others view technology-sharing as a way to pay the debt

Japan owes foreigners who openly shared their scientific and technological resources when, as a war-ravaged nation, it sought to rebuild. Whatever the reason, Japanese R&D policy now must address several goals rather than the previous single goal of catching up with the West. The challenge is more than simply boosting spending; Japan will need to reorder priorities and assume new roles.

Aggregate statistics - According to the latest government survey, total R&D spending in Japan rose 8 percent to Y10,627.6 billion ($70.9 billion at Y150=$1.00) in the 12-month period ending March 31, 1989 (see Table 1a). Although this represents a faster growth rate than the previous two years, it still is below the double-digit performances logged in FY 1983 and FY 1985. Data arranged by spending organization shows the corporate sector in the lead with an 11.2 percent gain to just over Y7.2 trillion ($48 billion), overshadowing the much weaker performances by universities -- up 2.9 percent to barely more than Y2 trillion ($13.3 billion) -- and research institutions, which registered a tiny 0.7 percent increase to just under Y1.4 trillion ($9.3 billion). By virtue of their strong performance companies expanded their share of total R&D spending to just under 68 percent.

The private sector also led the way when the data are presented according to funding source (Table 1b). While the business community's 10.2 percent expansion was significant in its own right (although not spectacular given the 12 to 14 percent gains registered in the early 1980s), the stagnation of government-financed R&D was the real story. Public R&D funds grew a mere 0.3 percent in FY 1988, dropping the government's share of total R&D funding to less than one-fifth for the first time since this type of statistic was released. Until FY 1988 the R&D budget had managed to escape the Ministry of Finance's fiscal austerity axe. If the growth of government spending does not return to robust health, Tokyo's commitment to becoming a technology source for the world surely will be questioned.

Data on Japanese R&D by purpose also cast doubt on Japan's willingness to become a source of basic research knowledge. Money for developmental work, which leads directly to commercial products, took a bigger share of total R&D spending in FY 1988, while the portion allotted to basic research edged back (see Table 2). Those fairly consistent percentages followed a six-year pattern that indicates that commercial technology remains Japan's top R&D priority.

Data broken down by purpose by spending organization underscore both of the above trends (see Table 3). The breakdown of corporate work among basic, precommercial and commercial research was unchanged in FY 1988. (This implies, however, that basic research by companies grew 11.2 percent, the same rate of increase as overall company spending.) Basic research outlays by both universities and research institutions were down as a percentage of total spending. The slight decline in basic research undertaken by universities was ominous since university work, which is subject to the whims of bureaucrats and politicians, constitutes the bulk of basic research in Japan.

Government Spending - Faced with ballooning interest payments on the national debt, fiscal austerity has been Tokyo's watchword on spending since

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the early 1980s (see JEI Report No. 26A, July 7, 1990). To balance the budget the Ministry of Finance has tried to enforce on other ministries a policy of zero growth for capital expenditures (such as public works and other infrastructure) and cuts in current outlays (including administrative costs and wages). The government was able to keep a lid on new spending through the mid-1980s, but its grip began to slip at the end of the decade. The importance Tokyo attaches to R&D clearly is more than rhetorical; Table 4 shows that the growth of research outlays outpaced the expansion of both total and discretionary spending during most of the years of strictest austerity. The data also show, however, that R&D spending is not sacrosanct. In recent years in particular R&D outlays have not kept up with overall or discretionary spending.

When government spending is broken down by ministry for the latest two fiscal years (see Tables 5 and 6), the goals of Tokyo's R&D policies become obscured by a confusing pattern of changes in annual outlays. Some agencies, the Labor Ministry for example, post big gains one year but suffer cuts the next. Ministries that might be expected to have a strong claim to government R&D funds show surprisingly weak gains, such as the Ministry of Posts and Telecommunications. Nevertheless, some insights can be drawn from the data. Ministries with the greatest responsibility for R&D policy -- the Ministries of Education and International Trade and Industry plus the Science and Technology Agency -- naturally account for the largest allocations and show the most dependable growth. Some specific priorities also are clear. Defense-related R&D outlays have grown strongly and steadily over the past several years. In addition, the jump in FY 1990 funding for the Environment Agency may signal a long-term commitment in this field.

A better idea of each agency's thinking can be gleaned from a detailed look at FY 1990 spending plans (see Table 7). Nuclear power is high on the list of several agencies, including STA, MITI and the Foreign Ministry. Promoting new technologies -- STA's Space Development Association and New Technology Development Association, MITI's large-scale industrial technology program and the Ministry of Transportation's magnetic levitation research, for example -- remains a salient feature of spending. Fairly new to the list are programs aimed at basic research, including MITI's Human Frontiers Science Program and the Basic Technology Promotion Center (a joint venture of MITI and the Ministry of Posts and Telecommunications). Environmental issues also are gaining attention, with most ministries launching programs in this area (albeit often very small ones). The Environment Agency has rededicated its former disaster prevention institutes to the study of global environmental issues. MITI's Global Environment Industrial Technology Institute, moreover, is expected to have an even larger budget in FY 1991.

Tokyo is clearly sticking with policies that have helped foster the nation's technology successes -- policies that focus on developing precommercial know-how. New wrinkles are appearing in the form of greater support for basic and international research ("international" in that it either involves foreign participation or is aimed at global issues). How well these new categories fare in future budget negotiations will be one indicator of Tokyo's commitment to playing a larger global role.

Private Spending - The data in Table 1 make it clear that while government spending is nothing to ignore, the real R&D action in Japan happens in the private sector. Companies outspent the government four-to-one in FY 1988, a ratio that probably has tipped even more toward the private sector's favor

since then, if reports of double-digit business spending growth are true. Intense competition -- both domestic and foreign -- has forced Japanese companies to adopt a strong technology development program as a key element of their business strategies. While not completely immune to corporate planners' profitability scales, R&D budgets have been spared the full blow of the cost cutter's axe during slow business periods because many managers see R&D as crucial to their firm's future competitiveness. They and others attribute record corporate profits during the late 1980s, at least in part, to vigorous R&D spending in previous years. These record profits, in turn, have led to even larger R&D budgets, which are expected to further strengthen the competitive position of Japanese firms in the 1990s.

The latest government data on private R&D extend only through FY 1988 (see Table 8). Nevertheless, the upsurge in research activity in the business sector is clear from the near-doubling of the growth of spending in FY 1988. Only two industries recorded declines that year compared with seven the year before. Fourteen areas showed double-digit growth rates in FY 1988 compared with 10 in the previous period. Agriculture's string of big increases was notable, as was the rebound in research spending by the mining and the motor vehicle industries.

The commitment of Japanese management to R&D is obvious when it is expressed as a share of gross sales (see Table 9). Only one sector, agriculture, recorded a lower R&D-to-gross sales ratio in FY 1988 than in FY 1978; even then, agriculture's ratio had been on the rise since FY 1983. While a handful of industries showed only modest improvement in this ratio, many raised their figures by 50 to 100 percent. This was particularly true for "low technology" industries, such as textiles, food products and publishing. At the other end of the scale outlays by the pharmaceuticals, electronics and precision machinery industries led the pack.

Since private R&D is at the cutting edge in many fields, it is not surprising that Japanese corporations feel pressure similar to that put on Tokyo to share their know-how with the rest of the world. Japanese companies are faced with two demands: increase funding for basic research (which is to be freely shared) and transfer more technology to foreign partners. As mentioned earlier, the business sector did not change the way it split R&D outlays among basic, applied and developmental research between FY 1987 and FY 1988. The situation was far from static, however. Table 10 shows that while the overall figures did not change, the allocations by individual industries underwent small but definite shifts. Again, it is unsurprising to find that the petroleum and coal products industry and the chemical industry (pharmaceuticals, in particular) devote a relatively high proportion of their R&D budgets to basic research. One interesting development was the sharp increase in basic research by the mining industry, although the reasons for this reallocation were not clear.

Technology Trade - Perhaps one of the most aggravating Western stereotypes of Japanese companies is that they scavenge the globe for useful technologies but jealously horde domestically developed know-how. Most of Japan's biggest export items -- motor vehicles and industrial or consumer electronics -- were invented overseas. By licensing or copying (or, some would charge, stealing) basic technologies and adding domestic innovations in product and process technologies, Japanese firms rapidly rebuilt their industrial competitiveness. Foreign countries now feel that Japan somehow "owes" the rest of the world for

its commercial success and the economic dislocations that success has caused overseas.

The latest government data on technology flows indicate, however, that Japan has not fully come to terms with this perception. Imports of technology in FY 1988 still surpassed exports in both the number of transactions and their total value (see Tables 11 and 12). Although the gap is narrower for new technology transactions (excluding payments or renewals of previous deals), the lack of an export trend is not encouraging for Japan's reputation. The picture becomes more troublesome when the data are broken down by industry (see Table 13). The manufacturing sector naturally accounts for the bulk of activity, but the gap between technology imports and exports by this sector as a whole widened between FY 1987 and FY 1988, particularly in terms of the number of transactions.

When technology trade is analyzed by country (see Table 14), the picture is only slightly more encouraging. Exports of Japanese technology to Asian nations, the United States and Western Europe generally exhibited good gains between FY 1985 and FY 1988. Imports of technology, however, particularly from the United States, turned in an even stronger performance. This translated into a widening technology deficit for Japan with its major technological competitors, which also happen to be its major trading partners. It is also clear that Japan is not focusing much attention on developing nations outside of Asia. These two points spell trouble for Japan's efforts to play a global role commensurate with its economic might.

Internationalization of Japanese R&D

Paralleling Japan's rise to the status of economic superpower has been the growing debate, both in Japan and abroad, over the country's new international responsibilities. "Globalization" and "internationalization" have become buzzwords in the Japanese lexicon but are vaguely defined. As they apply to Japanese R&D policy, however, the words take on a more concrete meaning. Globalization of Japanese R&D means establishing ties to foreign research resources and building a research presence overseas. Internationalization carries the process one step further by diffusing Japanese technology to foreigners through the promotion of foreign research activities in Japan, dissemination of Japanese research more widely and elimination of the distinctions between Japanese and foreign research activities. Globalization of Japanese R&D is well along. Internationalization, however, is just beginning. Not only are Japanese companies and public research organizations having difficulty implementing this idea, but foreigners are greeting Japanese initiatives with more than a touch of suspicion.

Government Efforts - Bilateral cooperation pacts have been a staple of Japan's research policy. Japanese researchers have been welcomed at U.S. government research facilities for many years, particularly at the National Institutes of Health. In addition, Washington and Tokyo have cooperated on many projects in the energy field, including nuclear power and alternative energy sources. Technology cooperation in defense was formalized by a November 1983 exchange of diplomatic notes but has yet to induce a significant flow of technology from Japan. In fact, the 1988-89 flap over Japan's FSX fighter aircraft program (see JEI Report No. 21A, May 26, 1989) has soured the atmosphere for bilateral transfers of military technology, at least temporarily. Cooperation in the scientific and civilian aerospace fields has been smoother. Japan's participation in the U.S. program for a permanently manned space station is an

important element in the overall operational scheme. Moreover, a Japanese astronaut has a reservation aboard the U.S. space shuttle for sometime next year. Tokyo's cooperative research pacts with many European countries and the extension of technological assistance to many developing countries indicate that the globalization of Japanese government R&D is firmly under way.

Tokyo's first attempt at internationalizing government-funded R&D came in 1986 when then Prime Minister Yasuhiro Nakasone announced a 20-year international project to explore basic biological functions. The Human Frontiers Science Program was a unique proposal: Tokyo would provide up to half of the projected Y1 trillion ($6.7 billion) cost; moreover, foreign researchers would not simply participate in the research but would direct certain portions as well. Unaccompanied by details, the plan was slow to take shape. When Tokyo began filling in the blanks, however, it ran into a great deal of resistance from foreign research institutes and governments suspicious of the unprecedented nature of Japan's offer. Only after Tokyo agreed to establish an independent foundation in Strasbourg, France to administer the program were foreigners more forthcoming. Even then Tokyo's failure until FY 1989 to appropriate significant funds for the new program continued to feed foreign doubts.

More than four years after the project was announced the HFSP foundation has received 239 applications for research grants, 202 applications for long-term fellowships, 11 requests for short-term fellowships and 36 proposals for workshops. Summary information on the successful applicants is presented in Table 15. Foreign researchers are receiving the majority of support, accounting for 77.5 percent of the long-term fellowships, 70 percent of the research grants and 65 percent of the research grant funds. Foreign countries also are benefiting: 45 of the 80 long-term fellowships will be conducted in the United States, eight each in West Germany and Canada, seven in France, five in Britain and just four in Japan. MITI plans to spend more than Y1.3 billion ($8.7 million) on HFSP in FY 1990 and has requested a little under Y1.7 billion ($11.3 million) for the upcoming fiscal year. After a rocky start HFSP seems to be off on the right foot.

Tokyo's next move was to open existing or planned government-industry research consortia to foreign firms. During FY 1989 at least eight foreign firms (often via their Japanese subsidiaries) joined new public-private research projects, an approach credited as key to Japan's rapid development of technology. International Business Machines Corp. and Thomson CFS of France are charter members of the International Fuzzy Engineering Institute, which is developing computers that can handle ambiguous inputs or data. General Electric Co. and the Pratt & Whitney division of United Technologies Corp. agreed in 1989 to join a MITI consortium developing a jet engine for a Mach 5 aircraft. Other consortia that have attracted foreign interest are aimed at developing advanced electric/electronic appliances, nonlinear optical materials, biodegradable plastics and next-generation composite materials. Japanese officials are disappointed that foreign firms have not been more aggressive in taking advantage of this open-door policy. Foreign firms grumble that some of the critical projects, such as X-ray lithography, are closed to them or that participation is too expensive.

Tokyo's newest international initiative is the Intelligent Manufacturing System. First proposed in late 1989 by the Ministry of International Trade and Industry, IMS is envisioned as "an advanced production system which, through interface of man and intelligent machinery, integrates the entire manufacturing process from order through design, production and distribution." MITI, in

essence, is proposing a single computer standard that would replace standards that have been developed independently to handle various stages of production (for example, Electronic Data Interchange for order handling, General Motors Corp.'s Manufacturing Automation Protocol and Boeing Co.'s Technical and Office Protocol). MITI originally was willing to put up two-thirds of the 10-year project's estimated Y150 billion ($1 billion) price tag and submitted the proposal to all 24 members of the Organization for Economic Cooperation and Development. After signing up 64 Japanese firms to participate (not without some difficulty), MITI established the IMS Promotion Center, which includes foreign firms (United Technologies and Rockwell International Corp., for example), to manage the project. The Society of Mechanical Engineers, a Michigan-based trade association, was picked in May to promote the project in North America.

Although American and European firms see some potential gains from the project (if it is managed correctly), the IMS proposal set off alarm bells in Washington and Brussels, the headquarters of the European Community. U.S. and EC officials publicly charged that the plan was nothing more than a ruse to erase the American and the European leads in some areas and to establish Japanese dominance in manufacturing technologies. Both Washington and Brussels insisted that the project be handled at the government-to-government level, a move Tokyo initially resisted. The United States and the EC also demanded that the cost of the project be born equally by the three partners and that they be allowed to submit their own ideas about program goals and structure. The Department of Commerce claimed negotiating authority under the 1988 U.S.-Japan Science and Technology Agreement and set late September initial public discussions with U.S. industry. Industry opinions will be incorporated into departmental proposals to be presented to Japan and the EC at a meeting this fall.

MITI officials are frustrated by foreign reactions to their first attempts to internationalize Japan's research efforts. "Damned if you don't and damned if you do" aptly sums up their feelings. To be sure, foreigners do have some legitimate complaints about Japan's approach. Important issues, such as intellectual property rights, often are neglected or clumsily handled. Nevertheless, Japan's experience so far underscores the sensitivity and the importance of the internationalization effort. It is unlikely that Tokyo will back off from the task, but it may be more careful about how it structures and implements future initiatives.

Private Efforts - The high level of private-sector R&D spending in Japan is attracting increased attention from foreign governments and companies. Many Americans argue, for example, that bilateral technology flows will remain heavily in Japan's favor until Japanese companies open their research programs to foreigners in the same way that American universities and research institutes open their doors to Japanese. Understandably, such opinions gall Japanese firms that deem their technological prowess to be due more to their own hard work than anything learned from abroad. Nevertheless, political and business realities are forcing Japanese firms to globalize and internationalize their R&D.

According to a major Japanese electronics firm, corporate globalization has clearly defined stages: globalization of markets (exports), followed by globalization of production (overseas factories), then globalization of corporate finance (raising and investing funds in overseas markets) and, finally, globalization of technology (conducting research abroad). Beginning in the 1970s Japanese firms began opening small R&D centers overseas for one of two

reasons: to monitor local technology developments and transfer the information back to Japan (vertical technology transfers) or to tailor products to meet local needs (horizontal technology transfers). The success of Japanese cars and some consumer electronics products in the U.S. market can be attributed in part to the American design centers established by Japanese firms.

Globalization of corporate technology is the next step and can take several forms. Many Japanese automotive makers are upgrading their American design offices to handle the task of developing new models from the ground up. While technical information is passed back and forth between the American engineering teams and their Japanese counterparts, the foreign engineering operation is expected to become highly autonomous. In some cases the upgraded overseas research facility becomes fully integrated into the domestic research program, thus allowing foreigners to become "insiders" without traveling to Japan. Other Japanese companies, such as NEC Corp., have founded research centers in the United States modeled after the traditional research institute that focuses on basic research in an open academic environment. Although there usually are a few Japanese company scientists pursuing research at these new institutes, the majority of openings are offered to local scientists. Still other companies are opening research facilities targeted at a specific market. For example, Matsushita Electric Industrial Co., Ltd., Sony Corp. and Toshiba Corp. all have opened U.S. laboratories to develop high-definition television technology.

According to a 1990 Science and Technology Agency survey, 89 Japanese firms capitalized at more that Y1 billion ($6.7 million) have established 188 R&D centers employing 4,300 people worldwide. North America is the home of more than 80 percent of these centers, far ahead of Europe (11 percent) and Asia (4 percent). Respondents gave the following reasons for setting up overseas R&D facilities: to develop technologies tailored to offshore markets (59.6 percent), to globalize business activities (34.6 percent), to enhance the technological levels of foreign factories (29.4 percent), to promote research ties to universities and train personnel (23.5 percent) and to attract talented local employees (21.5 percent). Globalization and internationalization have yet to become firmly rooted in the minds of Japanese management, however. Of the 833 companies surveyed, only 17 percent said they had or would set up overseas R&D facilities; 53 percent were undecided and 30 percent said they no intention of doing so.

Globalization also affects domestic research efforts. Japanese companies are opening their research facilities at home to foreigners, if slowly. Hitachi, Ltd. (35 positions), NEC (26 openings) and Nippon Telegraph and Telephone Corp. (50 fellowships) include foreign scientists on the staff of some of their top research laboratories. Foreign critics point out, however, that such programs remain minute in comparison to Japanese access to foreign research facilities.

The skyrocketing cost of R&D in some fields is forcing Japanese firms to find foreign partners to share the risks. Hitachi and Texas Instruments Inc. penned an accord in 1988 to jointly develop the next generation of memory chips. American Telephone & Telegraph Co. struck a similar agreement this year with Mitsubishi Electric Corp. IBM has agreed with various Japanese firms to develop computer components, such as high-performance liquid crystal displays. The Electronic Industries Association of Japan and the Semiconductor Industry Association have hammered out a project to jointly develop electronic components for advanced televisions.

In other cases Japanese and foreign firms have entered into joint research agreements to compensate for each other's weaknesses. Motorola Inc. and Toshiba, for example, are exchanging microprocessor (Motorola) and memory (Toshiba) technologies. NEC and AT&T have a similar agreement covering design technology for application-specific integrated circuits.

Japanese firms also are trading their technological expertise for a foothold in foreign markets. Japanese steelmakers, for example, have provided technology to vertically integrated American steel companies through joint ventures. In Brazil, where foreign investment is restricted, Japanese companies hoping to do business usually must find a joint venture partner and transfer the relevant know-how; this is a pattern common to Japanese companies' dealings with many developing countries.

Despite all this activity Japanese companies remain under pressure from abroad and at home to do more. Some Japanese scholars suggest that one way to reduce the country's trade surplus is for Japanese firms to transfer product and process technologies abroad rather than export final goods. U.S. officials want Japanese firms to transfer more technology that has military applications as well as civilian uses, but this remains a highly sensitive topic. Japanese companies are struggling to find the right balance between sharing with the world the fruits of their massive R&D programs and retaining a proprietary hold on key technologies.

Conclusion

Japan's R&D machine clearly is well fed, productive and growing stronger. Its products match -- and, in some areas, surpass -- the best that the United States or Europe has to offer. Japanese business and government leaders have good reason to take pride in the rapid development of such a powerful technology base after World War II's decimation of the economy. As Japan has changed, however, so has the global environment. Japanese companies understand that they no longer can be only technology buyers in the global arena but must become technology suppliers as well. Contributing to the world's supply of knowledge also could be more than just good business for Japan: It is one way to respond to international criticism that Japan has little sense of its global role or responsibilities. As Tokyo's experiences with the Human Frontiers Science Program and the Intelligent Manufacturing System project show, however, overcoming foreign suspicions is not a simple task.

Nevertheless, both the Japanese government and the private sector have added new priorities to their R&D programs and have begun altering behavior patterns. Greater contributions to basic science as well as better dissemination of Japanese technology abroad surely will be long-term products of the changes now under way. At the same time, however, the process of restructuring Japan's R&D machine no doubt will be slow and will demand difficult adjustments by both Japanese and foreigners alike.

For further information, contact Jon Choy.

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The views expressed in this report are those of the author and do not necessarily represent those of the Japan Economic Institute.

Table 1: Japan's R&D Expenditures, FY 1983-FY 1988

(in billions of yen and percent)

a. By Spending Organization

Fiscal Year	Companies	Research Institutions	Universities	Total
1983	Y4,560.1	Y971.0	Y1,649.6	Y7,180.8
Change	12.9%	2.3%	7.1%	10.0%
Share	63.5%	13.5%	23.0%	100.0%
1984	5,136.6	1,033.1	1,724.2	7,893.9
Change	12.6%	6.4%	4.5%	9.9%
Share	65.1%	13.1%	21.8%	100.0%
1985	5,939.9	1,160.6	1,789.8	8,890.3
Change	15.6%	12.3%	3.8%	12.6%
Share	66.8%	13.1%	20.1%	100.0%
1986	6,120.2	1,240.2	1,832.6	9,192.9
Change	3.0%	6.9%	2.4%	3.4%
Share	66.6%	13.5%	19.9%	100.0%
1987	6,494.3	1,384.5	1,957.9	9,836.6
Change	6.1%	11.6%	6.8%	7.0%
Share	66.0%	14.1%	19.9%	100.0%
1988	7,219.3	1,394.2	2,014.1	10,627.6
Change	11.2%	0.7%	2.9%	8.0%
Share	67.9%	13.1%	19.0%	100.0%

b. By Source of Funds

Fiscal Year	Government	Private	Foreign	Total
1983	Y1,721.4	Y5,451.1	Y8.2	Y7,180.8
Change	3.3%	12.3%	17.1%	10.0%
Share	24.0%	75.9%	0.1%	100.0%
1984	1,777.8	6,108.6	7.6	7,893.9
Change	3.2%	12.1%	-7.3%	9.9%
Share	22.5%	77.4%	0.1%	100.0%
1985	1,867.3	7,014.9	8.1	8,890.3
Change	5.0%	14.8%	6.6%	12.6%
Share	21.0%	78.9%	0.1%	100.0%
1986	1,955.3	7,229.7	7.9	9,192.9
Change	4.7%	3.1%	-2.5%	3.4%
Share	21.5%	78.4%	0.1%	100.0%
1987	2,111.8	7,716.6	8.2	9,836.6
Change	8.0%	6.7%	3.8%	7.0%
Share	21.5%	78.4%	0.1%	100.0%
1988	2,117.8	8,501.5	8.3	10,627.6
Change	0.3%	10.2%	1.2%	8.0%
Share	19.9%	80.0%	0.1%	100.0%

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 2: Japan's Research Expenditures by Purpose, FY 1983-FY 1988

(in billions of yen and percentage share)

Fiscal Year	Basic Research	Applied Research	Developmental Research
1983	Y896.7	Y1,630.1	Y3,882.8
	14.0%	25.4%	60.6%
1984	959.9	1,780.8	4,340.2
	13.6%	25.1%	61.3%
1985	1,030.6	2,001.8	4,985.9
	12.9%	25.0%	62.2%
1986	1,102.8	2,030.8	5,185.0
	13.3%	24.4%	62.3%
1987	1,250.2	2,166.8	5,497.3
	14.0%	24.3%	61.7%
1988	1,288.0	2,346.6	6,041.0
	13.3%	24.3%	62.4%

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 3: Japan's Research Expenditures by Spending Organization by Purpose, FY 1983-FY 1988

(share of each organization's total expenditures in percent)

Fiscal Year	Basic Research	Applied Research	Developmental Research
1983			
Universities	57.4%	35.0%	7.6%
Research Institutions	13.2	33.2	53.6
Companies	5.2	21.8	73.0
1984			
Universities	54.9	36.9	8.3
Research Institutions	12.6	30.9	56.5
Companies	5.7	22.0	72.3
1985			
Universities	54.2	37.4	8.4
Research Institutions	12.3	30.0	57.7
Companies	5.9	21.9	72.1
1986			
Universities	54.2	37.4	8.4
Research Institutions	13.8	27.4	58.8
Companies	6.1	21.6	72.3
1987			
Universities	54.2	37.4	8.4
Research Institutions	15.8	26.0	58.2
Companies	6.6	21.7	71.7
1988			
Universities	52.8	38.5	8.7
Research Institutions	14.9	25.4	59.7
Companies	6.6	21.7	71.7

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 4: Japanese Government Research Expenditures as a Share of the General Account Budget, FY 1982-FY 1990

(revised budgets in billions of yen and percent)

a. As a Share of Total Expenditures

Fiscal Year	Total Expenditures	Research Expenditures	Share
1982	Y47,562.1	Y1,448.0	3.0%
1983	50,839.4	1,448.9	2.8
1984	51,513.4	1,477.6	2.9
1985	53,222.9	1,521.6	2.9
1986	53,824.8	1,599.0	2.9
1987	58,241.2	1,655.0	2.8
1988	61,851.7	1,715.7	2.8
1989	66,311.9	1,814.8	2.7
1990*	66,236.8	1,919.6	2.9

b. As a Share of Discretionary Expenditures

Fiscal Year	Total Expenditures	Research Expenditures	Share
1982	Y33,120.0	Y1,448.0	4.4%
1983	35,356.8	1,448.9	4.1
1984	33,244.5	1,477.6	4.4
1985	33,352.3	1,521.6	4.6
1986	33,425.7	1,599.0	4.8
1987	35,276.5	1,655.0	4.7
1988	36,789.8	1,715.7	4.6
1989	39,257.4	1,814.8	4.6
1990*	36,673.1	1,919.6	5.2

*Initial budget.

Source: Ministry of Finance

Table 5: Japanese Government R&D Expenditures, FY 1989

(in millions of yen and percentage change)

	Science Promotion	Energy and Other Research	Special Research	Total
Diet	Y533	Y0	Y0	Y533
	3.0%	--	--	3.0%
Japan Technology Council	0	867	0	867
	--	-4.0%	--	-4.0%
Police Agency	1,020	0	0	1,020
	4.9%	--	--	4.9%
Hokkaido Development Agency	147	0	0	147
	3.1%	--	--	3.1%
Defense Agency	0	93,068	0	93,068
	--	12.5%	--	12.5%
Economic Planning Agency	764	0	0	764
	6.7%	--	--	6.7%
Science and Technology Agency	189,400	166,043	111,181	466,623
	10.8%	-2.0%	11.4%	6.0%
Environment Agency	7,882	0	0	7,882
	1.7%	--	--	1.7%
Justice Ministry	871	0	0	871
	2.6%	--	--	2.6%
Foreign Ministry	0	6,408	0	6,408
	--	-0.1%	--	-0.1%
Finance Ministry	348	0	738	1,087
	3.3%	--	15.2%	11.1%
Education Ministry	68,439	128,366	657,517	854,322
	7.3%	0.7%	5.7%	5.1%
Health Ministry	36,371	1,161	10,838	48,370
	12.5%	2.9%	2.1%	9.8%
Agriculture Ministry	62,350	1,929	3,400	67,679
	1.9%	4.5%	-5.6%	1.6%
International Trade and Industry Ministry	55,799	13,628	164,213	233,640
	2.1%	-0.7%	7.4%	5.6%
Transportation Ministry	13,255	2,162	913	16,300
	6.4%	73.0%	-0.3%	11.4%
Posts and Telecommunications Ministry	4,341	105	26,000	30,447
	4.1%	-6.8%	0.0%	0.5%
Labor Ministry	612	1	3,945	4,557
	1.8%	0.0%	27.0%	22.9%
Construction Ministry	5,376	313	0	5,689
	3.3%	23.3%	--	4.2%
Home Affairs Ministry	555	0	0	555
	2.2%	--	--	2.2%
Total	448,032	414,049	952,745	1,814,827
	7.4%	2.2%	6.7%	5.8%

Source: Science and Technology Agency

Table 6: Japanese Government R&D Expenditures, Planned FY 1990

(in millions of yen and percentage change)

	Science Promotion	Energy and Other Research	Special Research	Total
Diet	Y533	Y0	Y0	Y533
	0.0%	--	--	0.0%
Japan Technology Council	0	951	0	951
	--	9.7%	--	9.7%
Police Agency	1,055	0	0	1,055
	3.4%	--	--	3.4%
Hokkaido Development Agency	149	0	0	149
	1.4%	--	--	1.4%
Defense Agency	0	104,268	0	104,268
	--	12.0%	--	12.0%
Economic Planning Agency	809	0	0	809
	5.8%	--	--	5.8%
Science and Technology Agency	204,905	164,933	124,937	494,775
	8.2%	-0.7%	12.4%	6.0%
Environment Agency	9,217	0	0	9,217
	16.9%	--	--	16.9%
Justice Ministry	939	0	0	939
	7.8%	--	--	7.8%
Foreign Ministry	0	7,095	0	7,095
	--	10.7%	--	10.7%
Finance Ministry	358	0	730	1,087
	2.7%	--	-1.1%	0.1%
Education Ministry	74,637	129,907	689,721	894,301
	9.1%	1.2%	4.9%	4.7%
Health Ministry	38,831	1,319	10,092	51,242
	6.8%	13.5%	2.3%	5.9%
Agriculture Ministry	64,164	2,544	3,300	70,007
	2.9%	11.2%	-2.9%	2.9%
International Trade and Industry Ministry	55,580	12,912	181,340	249,832
	-0.4%	-5.3%	10.4%	6.9%
Transportation Ministry	13,060	3,311	1,039	17,410
	-1.2%	53.2%	13.3%	6.8%
Posts and Telecommunications Ministry	4,468	189	26,543	31,199
	2.9%	79.8%	0.5%	1.1%
Labor Ministry	630	38	3,522	4,190
	3.0%	5,483.6%	-11.0%	-8.1%
Construction Ministry	5,525	454	0	5,979
	2.8%	45.3%	--	5.1%
Home Affairs Ministry	565	0	0	565
	1.8%	--	--	1.8%
Total	475,460	427,921	1,016,222	1,919,603
	6.1%	3.3%	6.6%	5.7%

Source: Japan Society for the Promotion of Science, Japanese Scientific Monthly, July 1990.

Table 7: Expenditures on Selected Science Programs by Agency, FY 1989-FY 1990

(in millions of yen)

	FY 1989	FY 1990
Japan Defense Agency		
Technology development	Y92,068	Y104,268
Science and Technology Agency		
Agency research (including four air and space development organizations)	31,753	34,008
Physical Chemistry Research Institute	16,056	17,110
New Technology Development Association	1,850	1,775
Science and technology promotion survey	6,944	9,453
Space Development Association	106,757	116,293
Ocean development research	10,675	10,472
Ocean Science and Technology Center	10,359	9,645
Japan Nuclear Development Research Institute	94,845	97,587
Japan Reactor Development Center	61,217	56,643
National Nuclear Research Laboratory	2,043	2,060
Research management costs	9,867	10,667
Environment Agency		
National Environment Research Institute	4,556	4,899
Global environmental research	0	1,200
National Disaster Prevention Institute	2,283	1,928
Disaster prevention survey	869	1,015
Foreign Ministry		
International Atomic Energy Commission	2,616	2,956
OECD Nuclear Power Committee	191	200
Finance Ministry		
Brewing Research Institute	348	358
Education Ministry		
Research grants	52,600	55,800
Japan Technology Promotion Council grants	5,568	6,148
University research programs	657,517	689,721
National university research grants	128,366	129,907
Health Ministry		
Agency research	15,125	15,706
Research grants	17,825	18,844
Pharmaceutical research	2,400	2,300
Health science research	5,464	6,467
Cancer research projects	3,204	3,254
International cancer research	129	170
Medical and drug information system	212	242
Agriculture Ministry		
Agency research laboratories (including 29 agricultural research centers)	57,455	59,221
Large-scale projects	1,300	1,302
Biotechnology development	1,509	1,565
Large-scale agriculture research	1,300	1,302
Livestock research	4,244	4,171
Tropical agriculture research	624	672
Red tide research	288	278
Food product technology	518	589

Table 7 (continued)

(in millions of yen)

	FY 1989	FY 1990
International Trade and Industry Ministry		
Agency research (including 16 research centers)	40,248	40,849
Large-scale industrial technology projects	12,993	13,161
Basic computer technology development	3,722	3,462
Basic Technology Promotion Center	26,000	26,000
Next-generation basic technology projects	6,836	7,463
New energy technology development projects	27,139	27,475
Energy conservation projects	10,305	11,120
Nuclear energy development projects	27,434	29,772
Human Frontiers Science Program	932	1,337
International aircraft development	4,190	3,817
Global Environment Industrial Technology Institute	290	6,910
Small business technology improvement	1,630	1,612
Transportation Ministry		
Agency research (including five ship technology centers)	7,369	8,595
Geostationary weather satellite management	2,251	2,130
Geostationary weather satellite launches	3,481	3,272
Magnetic levitation train technology	900	2,017
Next-generation ship technology	746	800
Posts and Telecommunications Ministry		
Electrotechnical laboratories	4,341	4,468
Communications Frontier Research	247	389
Basic Technology Promotion Center	26,000	26,000
Labor Ministry		
Agency research	2,706	2,432
Industrial safety research	1,626	1,354
Japan Bioassay Research Center	1,238	1,313
Construction Ministry		
Agency research (including one engineering center)	4,654	5,426
Construction technology research	709	733

Source: Japan Society for the Promotion of Science, Japanese Scientific Monthly, July 1990.

Table 8: Japan's R&D Expenditures by Industry, FY 1987-FY 1988

(in billions of yen and percentage change)

	FY 1987		FY 1988	
	Total	Change	Total	Change
Agriculture	Y5.8	33.0%	Y8.2	41.4%
Mining	19.5	-9.8	28.1	44.1
Construction	128.3	5.9	148.5	15.7
Manufacturing	6,101.2	6.3	6,754.6	10.7
Food Products	179.1	21.7	179.3	0.1
Textiles	66.5	6.0	72.8	9.5
Pulp and Paper	33.5	-1.3	42.8	27.8
Publishing and Printing	21.7	32.0	25.4	17.1
Chemicals	1,095.9	11.4	1,190.2	8.6
Industrial Chemicals and Synthetic Fibers	452.5	10.6	501.5	10.8
Oils and Paints	111.4	13.9	116.3	4.4
Pharmaceuticals	380.7	11.3	416.2	9.3
Other	151.2	12.2	156.2	3.3
Petroleum and Coal Products	70.2	2.3	75.0	6.8
Plastic Products	85.9	22.8	90.9	5.8
Rubber Products	85.2	6.2	101.5	19.1
Nonmetallic Mineral Products	177.9	-5.2	198.6	11.6
Steel	245.2	-4.0	249.7	1.8
Nonferrous Metals	104.4	-5.2	120.3	15.2
Fabricated Metal Products	94.8	0.2	89.6	-5.5
Nonelectric Machinery	418.8	10.5	451.0	7.7
Electric Machinery	2,163.5	9.3	2,451.6	13.3
Communications and Electronics Equipment	1,497.8	10.1	1,709.8	14.2
Other	665.7	7.4	741.8	11.4
Transportation Equipment	969.6	-2.0	1,086.4	12.0
Motor Vehicles	814.8	-3.1	932.4	14.4
Other	154.8	3.7	154.0	-0.5
Precision Machinery	204.2	2.5	238.8	16.9
Other	84.9	4.6	90.8	6.9
Transportation, Communications and Utilities	239.4	2.6	279.9	16.9
Total	6,494.3	6.1	7,219.3	11.2

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 9: Japan's Ratio of Corporate R&D Expenditures to Gross Sales by Industry, FY 1978-FY 1988

(in percent)

Industry	FY 1978	FY 1983	FY 1987	FY 1988
Agriculture	0.60%	0.26%	0.31%	0.38%
Mining	0.54	0.59	1.01	1.27
Construction	0.42	0.53	0.51	0.49
Manufacturing	1.82	2.31	3.14	3.15
Food Products	0.51	0.70	0.99	0.89
Textiles	0.77	0.90	1.42	1.50
Pulp and Paper	0.49	0.63	0.77	0.87
Publishing and Printing	0.36	0.43	0.80	0.63
Chemicals	2.71	3.34	4.53	4.63
Industrial Chemicals and Synthetic Fibers	1.92	2.32	3.76	3.92
Oils and Paints	2.73	2.83	3.85	3.74
Pharmaceuticals	5.00	6.59	6.96	6.94
Other	3.03	3.04	4.00	4.11
Petroleum and Coal Products	0.27	0.26	0.64	0.83
Plastic Products	n.a.	n.a.	2.16	2.21
Rubber Products	2.60	2.40	3.25	3.19
Nonmetallic Mineral Products	1.29	1.82	2.82	2.73
Steel	1.08	1.60	2.40	2.13
Nonferrous Metals	1.00	1.49	1.90	2.00
Fabricated Metal Products	1.08	1.31	1.50	1.48
Nonelectric Machinery	1.93	2.57	2.99	2.60
Electric Machinery	3.74	4.70	5.61	5.53
Communications and Electronics Equipment	3.89	4.85	5.78	5.66
Other	3.59	4.40	5.26	5.25
Transportation Equipment	2.44	2.66	3.22	3.31
Motor Vehicles	2.60	2.89	3.17	3.31
Other	1.90	1.86	3.45	3.31
Precision Machinery	3.15	4.02	4.91	4.85
Other	1.16*	1.30*	1.12	1.14
Transportation, Communications and Utilities	0.35	0.39	0.84	0.95
All Industry Average	1.57	1.97	2.59	2.60

*Includes plastic products.

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 10: Japan's Corporate R&D Expenditures by Purpose, FY 1987-FY 1988

(in billions of yen and percentage share)

Industry	Basic Research		Applied Research		Developmental Research	
	1987	1988	1987	1988	1987	1988
Agriculture	3.6%	5.4%	16.2%	33.4%	80.3%	61.2%
Mining	17.9	23.0	16.5	31.3	65.5	45.7
Construction	6.9	5.7	26.4	29.7	66.7	64.6
Manufacturing	6.4	6.3	21.2	21.2	72.4	72.5
Food Products	9.2	10.1	29.9	31.7	60.9	58.2
Textiles	6.0	6.2	29.0	30.6	65.0	63.2
Pulp and Paper	7.4	5.1	32.9	31.1	59.7	63.8
Publishing and Printing	2.6	2.8	22.7	29.9	74.8	67.3
Chemicals	11.5	11.9	29.5	29.4	59.0	58.7
Industrial Chemicals and Synthetic Fibers	8.5	8.8	31.1	32.3	60.3	58.9
Oils and Paints	4.8	5.2	31.3	34.9	63.9	60.0
Pharmaceuticals	17.8	18.8	30.7	28.3	51.5	53.0
Other	9.5	8.7	20.0	19.1	70.5	72.2
Petroleum and Coal Products	14.1	13.3	20.7	20.9	65.1	65.9
Plastic Products	6.6	6.8	26.4	28.5	67.0	64.7
Rubber Products	5.3	4.8	17.6	17.0	77.0	78.2
Nonmetallic Mineral Products	8.1	7.6	21.9	20.1	70.0	72.3
Steel	7.8	9.8	25.9	24.5	66.4	65.7
Nonferrous Metals	3.5	3.5	27.4	28.9	69.0	67.6
Fabricated Metal Products	2.4	2.2	12.9	13.3	84.7	84.5
Nonelectric Machinery	4.4	4.4	19.9	20.4	75.7	75.2
Electric Machinery	4.4	4.3	18.7	19.1	76.9	76.6
Communications and Electronics Equipment	4.3	4.2	18.1	18.6	77.6	77.1
Other	4.8	4.5	19.8	20.1	75.4	75.4
Transportation Equipment	4.9	4.7	15.6	14.3	79.5	81.0
Motor Vehicles	4.9	4.6	14.0	12.9	81.1	82.5
Other	5.0	5.5	23.8	22.8	71.3	71.7
Precision Machinery	5.4	4.2	18.4	18.6	76.2	77.2
Other	7.8	4.3	14.8	19.9	77.3	75.8
Transportation, Communications and Utilities	11.7	12.5	30.8	28.2	57.4	59.3
All Industry Average	6.6	6.6	21.7	21.7	71.7	71.7

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 11: Japan's Technology Imports, FY 1950-FY 1988

(number of approved cases and value in billions of yen)

	Cases		Value	
	Total	Of Which New:	Total	Of Which New:
FY 1950-FY 1955	1,148	n.a.	Y24.9	n.a.
FY 1960	588	n.a.	34.2	n.a.
FY 1965	958	n.a.	60.1	n.a.
FY 1970	1,768	n.a.	155.9	n.a.
FY 1975	6,766	796	169.1	Y13.3
FY 1976	6,050	632	177.3	17.9
FY 1977	6,659	685	190.1	16.9
FY 1978	6,573	936	192.1	38.2
FY 1979	7,012	1,020	241.0	26.8
FY 1980	7,248	919	239.5	27.7
FY 1981	7,207	844	259.6	24.9
FY 1982	6,936	929	282.6	44.4
FY 1983	7,839	1,073	279.3	42.4
FY 1984	7,316	982	281.4	31.8
FY 1985	7,679	1,245	293.2	33.3
FY 1986	8,635	1,141	294.2	33.6
FY 1987	8,186	813	339.4	56.2
FY 1988	9,738	1,382	366.8	54.6

Table 12: Japan's Technology Exports, FY 1950-FY 1988

(number of approved cases and value in billions of yen)

	Cases		Value	
	Total	Of Which New:	Total	Of Which New:
FY 1950-FY 1955	n.a.	n.a.	Y0.3	n.a.
FY 1960	n.a.	n.a.	0.8	n.a.
FY 1965	n.a.	n.a.	6.1	n.a.
FY 1970	861	n.a.	21.2	n.a.
FY 1975	2,811	1,073	66.6	Y18.9
FY 1976	2,767	775	83.4	27.0
FY 1977	2,880	897	93.3	36.3
FY 1978	3,157	1,063	122.0	47.1
FY 1979	3,667	1,087	133.1	52.1
FY 1980	4,103	1,237	159.6	74.3
FY 1981	4,877	2,017	175.1	70.8
FY 1982	4,738	1,970	184.9	63.3
FY 1983	6,403	2,494	240.9	74.9
FY 1984	5,426	1,824	277.5	90.9
FY 1985	5,885	2,099	234.2	73.3
FY 1986	7,199	1,730	275.9	51.8
FY 1987	7,610	1,655	260.1	44.8
FY 1988	8,202	1,850	293.7	47.4

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 13: Japan's Corporate Technology Trade by Industry, FY 1987-FY 1988

(number of cases and value in billions of yen)

	FY 1987				FY 1988			
	Exports		Imports		Exports		Imports	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	5,955	Y215.6	7,373	Y283.2	6,352	Y246.3	8,356	Y312.2
Agriculture	5	0.1	4	0.0	8	0.1	5	0.0
Mining	12	1.0	41	0.2	11	0.1	35	0.1
Construction	229	12.8	151	0.9	387	16.8	171	1.0
Manufacturing	5,681	200.8	7,155	281.0	5,887	228.6	8,119	309.5
Food Products	96	5.0	103	9.8	118	5.8	123	13.4
Textiles	228	4.4	123	3.7	191	4.4	143	4.9
Pulp and Paper	30	0.4	35	0.5	29	0.5	27	0.8
Publishing	15	0.1	52	0.6	29	0.4	70	0.9
Chemicals	1,161	39.3	898	40.6	1,185	48.1	1,044	50.3
Synthetic Fibers	497	18.9	439	14.9	561	27.1	446	20.5
Fertilizers	234	3.0	131	3.7	241	3.1	259	4.3
Pharmaceuticals	285	16.1	210	13.6	294	16.3	231	18.2
Other	145	1.3	118	8.4	89	1.6	108	7.3
Petroleum and Coal Products	11	0.3	97	3.5	12	0.2	103	2.2
Plastic Products	81	1.3	77	0.9	95	1.3	84	1.2
Rubber Products	72	3.1	92	3.3	93	2.9	105	3.7
Nonmetallic Mineral Products	210	6.2	158	6.6	277	5.7	154	3.7
Steel	373	10.0	410	8.0	422	10.8	359	7.9
Nonferrous Metals	173	2.6	201	10.7	207	2.0	195	14.6
Fabricated Metal Products	170	1.3	238	2.9	155	1.1	172	2.2
Nonelectric Machinery	665	8.7	998	21.3	700	10.8	1,112	22.6
Electric Machinery	1,415	61.1	2,422	109.5	1,476	68.8	2,889	113.8
Machine Tools	598	21.3	441	34.5	670	21.0	473	34.5
Electronics	817	39.8	1,981	75.0	806	47.7	2,416	79.3
Transportation Equipment	688	49.2	876	48.8	684	58.4	789	52.0
Motor Vehicles	444	46.0	296	8.4	447	54.2	260	6.6
Other	244	3.2	580	40.4	237	4.2	529	45.4
Precision Machinery	124	2.9	249	6.7	114	4.6	255	7.3
Other	169	4.7	126	3.8	100	2.8	495	8.1
Transportation, Communications and Utilities	28	0.9	22	0.8	59	0.7	26	1.6

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 14: Japan's Corporate Technology Trade by Country, FY 1985-FY 1988

(number of cases and value in billions of yen)

a. Exports

	FY 1985		FY 1986		FY 1987		FY 1988	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Asia	3,047	Y87.5	2,748	Y86.5	3,152	Y86.4	3,264	Y101.4
China	417	26.4	454	19.7	405	9.4	339	8.4
Taiwan	559	7.9	532	8.5	590	12.3	660	13.2
South Korea	798	18.2	732	21.1	816	27.5	888	30.6
Thailand	214	6.2	203	5.4	294	7.3	331	9.9
Philippines	320	4.4	89	0.6	133	2.0	n.a.	n.a.
Indonesia	174	5.2	196	4.4	182	3.2	228	13.6
Malaysia	320	4.4	128	3.2	147	3.1	128	4.0
West Asia	167	14.1	94	10.5	52	1.6	59	2.3
North America	1,058	58.7	1,006	62.3	1,058	72.5	1,225	77.0
United States	896	51.8	869	57.7	912	65.9	1,080	71.1
South America	243	8.7	216	5.2	198	4.5	195	4.4
Brazil	133	3.3	127	3.8	107	2.5	114	2.5
Europe	1,072	45.5	1,040	43.6	1,184	40.3	1,281	49.3
Great Britain	183	5.3	161	7.6	190	10.6	221	13.9
West Germany	253	11.3	247	7.8	297	7.4	301	10.7
France	129	4.8	145	5.9	162	5.2	137	4.4
Netherlands	41	4.8	41	2.5	53	2.1	86	2.2
Switzerland	44	3.3	53	3.8	52	2.3	63	1.4
Africa	135	6.6	189	9.5	147	5.0	141	6.0
Oceania	163	13.0	176	6.6	164	5.3	187	5.9
Australia	124	11.9	139	5.8	116	4.2	134	5.2

b. Imports

	FY 1985		FY 1986		FY 1987		FY 1988	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Asia	169	Y0.9	15	Y0.3	12	Y0.1	29	Y0.2
China	114	0.7	4	*	2	*	0	0.0
Taiwan	1	*	0	0.0	2	*	15	0.0
South Korea	52	0.0	4	*	4	*	4	*
West Asia	2	*	94	10.5	2	*	0	0.0
North America	4,814	210.3	4,926	174.6	4,747	179.3	5,591	198.1
United States	4,772	208.6	4,825	173.8	4,667	178.6	5,495	196.9
South America	1	*	4	*	3	*	1	*
Europe	2,664	81.6	2,516	85.1	2,568	103.4	2,706	113.6
West Germany	859	17.6	903	20.7	847	21.4	835	18.4
Great Britain	566	14.6	477	13.0	512	10.3	451	9.3
France	285	6.8	298	7.3	313	22.1	432	26.2
Switzerland	319	16.3	241	17.5	273	17.4	277	18.4
Netherlands	156	15.5	163	15.6	173	20.8	182	27.6
Africa	1	*	3	*	3	*	0	0.0
Oceania	28	0.3	28	0.4	38	0.3	29	0.3

*Less than Y50 million.

Source: Management and Coordination Agency, Report on the Survey of Research and Development.

Table 15: Summary of Early Participants in the Human Frontiers Science Program

Research Grants	Number	Amount
Japan	9	$2,660,000
United States	8	1,900,000
United Kingdom	5	1,285,000
France	3	875,000
West Germany	1	300,000
Netherlands	1	250,000
Belgium	1	200,000
Canada	1	200,000
Total	29	7,670,000

Long-Term Fellowships By Nationality	Brain Functions	Molecular Studies	Total	Applicants
Japan	4	14	18	52
United States	0	9	9	19
United Kingdom	5	12	17	33
France	3	3	6	17
West Germany	1	4	5	15
Italy	1	2	3	15
European Community	2	4	6	11
Canada	2	3	5	8
Other	3	8	11	32
Total	21	59	80	202

By Host Country	Brain Functions	Molecular Studies	Total
Japan	0	4	4
United States	13	32	45
United Kingdom	1	4	5
France	2	5	7
West Germany	0	8	8
Italy	0	0	0
EC	1	1	2
Other	4	5	9
Total	21	59	80

By Host Organization	Brain Functions	Molecular Studies	Total
University of California	3	4	7
Salk Institute for Biological Studies	2	2	4
Max Planck Institute for Biophysics and Chemistry	0	4	4
Harvard University	1	2	3
California Institute of Technology	0	3	3
European Molecular Biology Laboratory	0	3	3
Utrecht University (Netherlands)	1	1	2
Stanford University	1	1	2
University of Colorado	1	1	2
Massachusetts Institute of Technology	0	2	2
Institute for Molecular Genetics	0	2	2
Cold Spring Harbor Laboratories	0	2	2
McGill Cancer Center	0	2	2
CNRS Institut de Biologie Physico-Chimique	0	2	2
Others	16	24	40
Total	25	55	80